Marine Corps *Electrical* Power

July 2004

Discussion Topics

- **Mobile Electric Power (MEP) Sources**
  - **MEP Study** ***Stand-Alone Presentation***
- **Advanced Power Sources**
  - **Alternative / Advanced Power Sources Program**
  - **Battery Management & Sustainment Systems**
    - **Battery Planning Study** ***Stand-Alone Presentation***
- **Other Technology Initiatives**
  - **Hybrid Electric Vehicles** ***Stand-Alone presentation***
  - **On-Board Vehicle Power Systems**
  - **Fuel Cells**
- **Issues / POM-08**

Mobile Electric Power

Generation

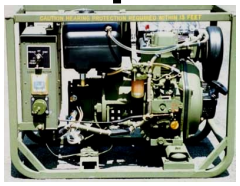
Distribution

3 kW TQG
MEP – 831A
B0730

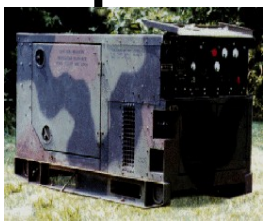
Commercial 25 kW
HMMWV Towable
Non-TQG
No TAMCN

60 kW TQG
MEP – 806 A/B – 60 Hz
MEP – 816A – 400 Hz
B1021 / B1016

15, 30, & 100 kW
MEPDIS
B0595 / B0600 / B0605

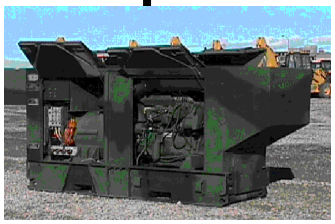


2 kW MTG
MEP – 531A
New to USMC



10 kW TQG
MEP – 803A – 60 Hz
MEP – 813A – 400 Hz
B0891 / B0921

30 kW TQG
MEP – 805 A/B – 60 Hz
MEP – 815A – 400 Hz
B0953 / B0971



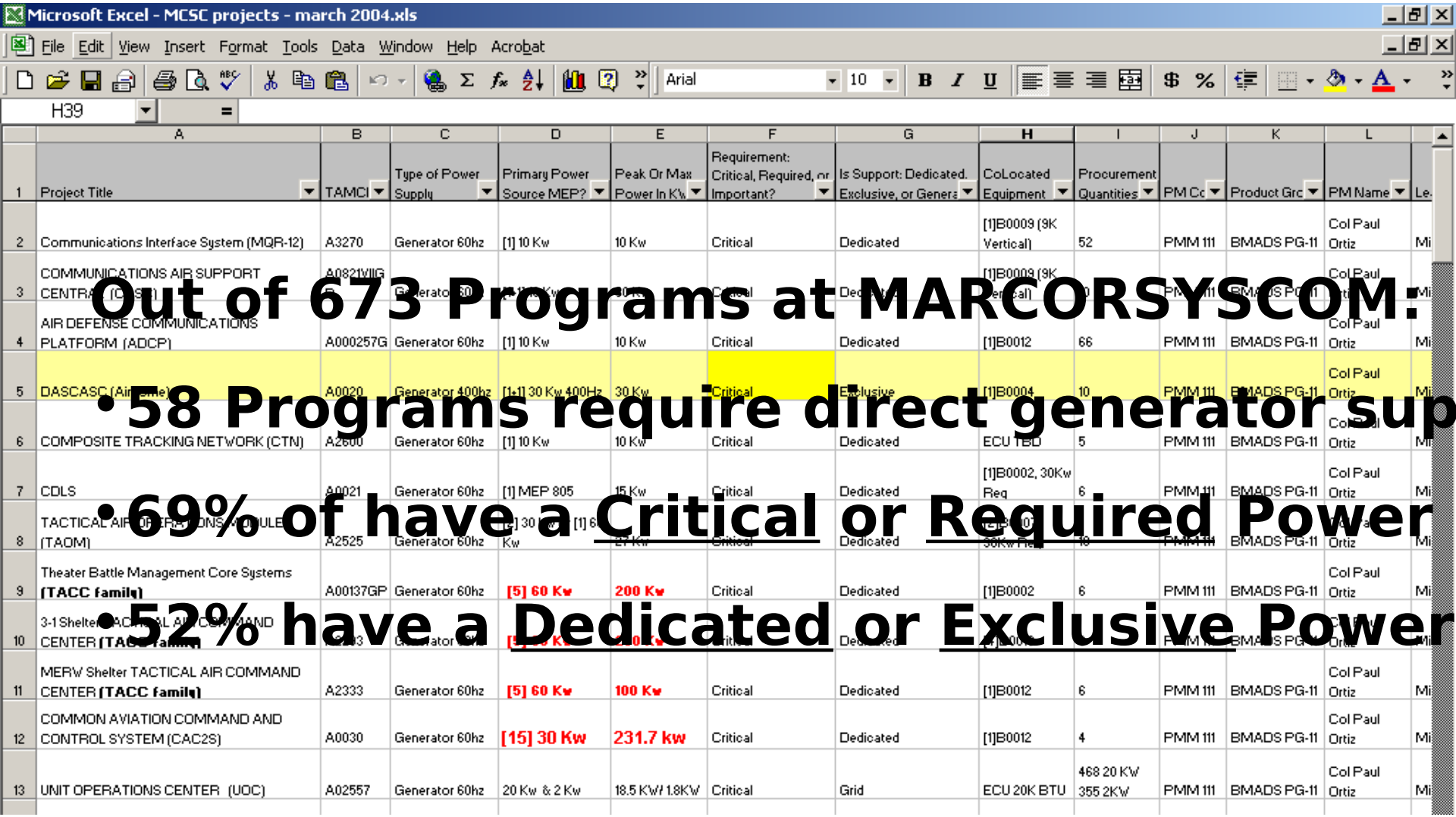
100 kW Mil-Std
MEP – 007A/B/C
B1045

100 kW TQG
MEP – 807A
Fielding in FY06

Mobile Electric Power Study

- **Focus of effort:**
  - **Where is MEP now?**
  - **Where is MEP going?**
  - **Are we buying the right type of power?**
  - **What can we add / remove / change / adjust**
- **Focus on what MARCORSYSCOM can**

Future Power Needs


Microsoft Excel - MCSC projects - march 2004.xls

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H39 =

	A	B	C	D	E	F	G	H	I	J	K	L
1	Project Title	TAMCI	Type of Power Supply	Primary Power Source MEP?	Peak Or Max Power In Kw	Requirement: Critical, Required, or Important?	Is Support: Dedicated, Exclusive, or Genera	CoLocated Equipment	Procurement Quantities	PM Cc	Product Grc	PM Name
2	Communications Interface System (MQR-12)	A3270	Generator 60hz	[1] 10 Kw	10 Kw	Critical	Dedicated	[1]B0009 (9K Vertical)	52	PMM 111	BMADS PG-11	Col Paul Ortiz
3	COMMUNICATIONS AIR SUPPORT CENTRA (CASC)	A0821VIIG	Generator 60hz	[1] 10 Kw	10 Kw	Critical	Dedicated	[1]B0009 (9K Vertical)	10	PMM 111	BMADS PG-11	Col Paul Ortiz
4	AIR DEFENSE COMMUNICATIONS PLATFORM (ADCP)	A000257G	Generator 60hz	[1] 10 Kw	10 Kw	Critical	Dedicated	[1]B0012	66	PMM 111	BMADS PG-11	Col Paul Ortiz
5	DASCASC (Airborne)	A0020	Generator 400hz	[1+1] 30 Kw 400Hz	30 Kw	Critical	Exclusive	[1]B0004	10	PMM 111	BMADS PG-11	Col Paul Ortiz
6	COMPOSITE TRACKING NETWORK (CTN)	A2600	Generator 60hz	[1] 10 Kw	10 Kw	Critical	Dedicated	ECU TBD	5	PMM 111	BMADS PG-11	Col Paul Ortiz
7	CDLS	A0021	Generator 60hz	[1] MEP 805	15 Kw	Critical	Dedicated	[1]B0002, 30Kw Req	6	PMM 111	BMADS PG-11	Col Paul Ortiz
8	TACTICAL AIR OPERATIONS MODULE (TAOM)	A2525	Generator 60hz	[1] 30 Kw [1] 6	27 Kw	Critical	Dedicated	[1]B0002, 30Kw Req	10	PMM 111	BMADS PG-11	Col Paul Ortiz
9	Theater Battle Management Core Systems **(TACC family)**	A00137GP	Generator 60hz	**[5] 60 Kw**	**200 Kw**	Critical	Dedicated	[1]B0002	6	PMM 111	BMADS PG-11	Col Paul Ortiz
10	3-1 Shelter TACTICAL AIR COMMAND CENTER **(TACC family)**	A2333	Generator 60hz	**[5] 60 Kw**	**200 Kw**	Critical	Dedicated	[1]B0012	6	PMM 111	BMADS PG-11	Col Paul Ortiz
11	MERW Shelter TACTICAL AIR COMMAND CENTER **(TACC family)**	A2333	Generator 60hz	**[5] 60 Kw**	**100 Kw**	Critical	Dedicated	[1]B0012	6	PMM 111	BMADS PG-11	Col Paul Ortiz
12	COMMON AVIATION COMMAND AND CONTROL SYSTEM (CAC2S)	A0030	Generator 60hz	**[15] 30 Kw**	**231.7 kw**	Critical	Dedicated	[1]B0012	4	PMM 111	BMADS PG-11	Col Paul Ortiz
13	UNIT OPERATIONS CENTER (UOC)	A02557	Generator 60hz	20 Kw & 2 Kw	18.5 KW/ 1.8KW	Critical	Grid	ECU 20K BTU	468 20 KW 355 2KW	PMM 111	BMADS PG-11	Col Paul Ortiz

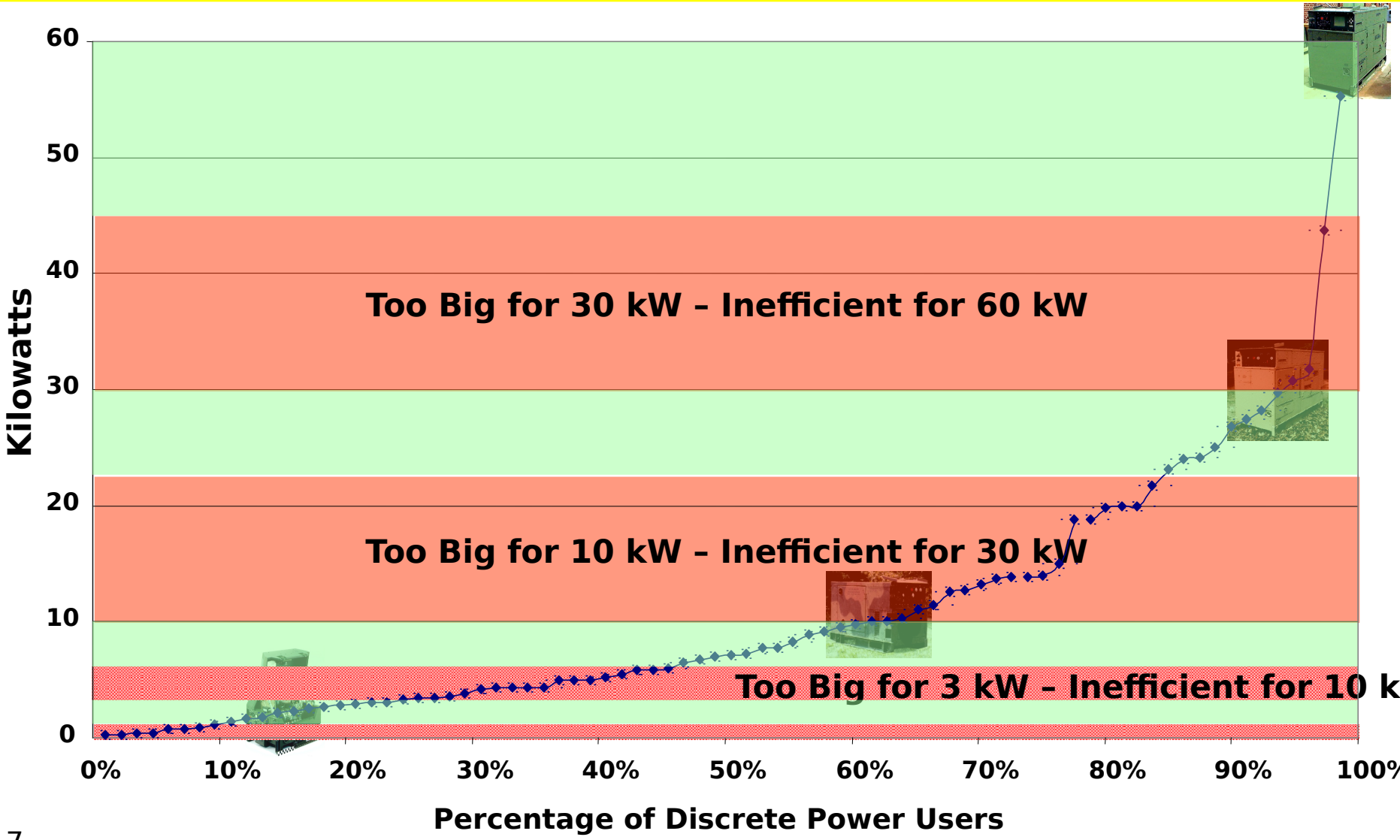
Out of 673 Programs at MARCORSYSCOM:

- **58 Programs require direct generator sup**
- **69% of have a Critical or Required Power**
- **52% have a Dedicated or Exclusive Power**

Power Classifications

- **Importance of Power**
  - Critical – Continuous tactical support 24/7. Loss of power is life threatening. (Radar, Communications, Emergency Medical Facilities)
  - Required – Extended loss of power is life threatening or causes loss of $$$$$. (ROWPUs, fuel farms, chow hall, Intermediate Maintenance)
  - Important – General Power, Non Tactical, Non-life threatening. Nice to have power. (MWR, Lights in tents, hair dryers)
- **Type of Distribution**
  - Dedicated Support – NOT grid power. Individual power support. Highly mobile or remote requirements. (Some radars and forward comm. equipment.)
  - Exclusive Support – Unique power requirements such as high voltage/high “Y”, 400hz power (TWPS, TPS-59 Radar, FireFinder Radar)
  - Grid Support – Static grid type support. One power source with multiple tasks. (Static communications and radar, maintenance shelters, billeting areas.)

Power inventory (MEU level)



Findings & Efforts

- **Small-Sized Generators (2, 3, 5 KW) – *most prolif***
  - Small systems need to be man-transportable
  - Meeting need with 2 kW and 3 kW diesel Generators

USMC does not field the DOD 5 kW & 15 kW generators

- **Mid-Sized Generators (10, 15, 25, 30 KW) – *growth industry***
  - 400 Hz generator needs being tailored down
  - Non-standard generators procured in support of OIF I/II
  - UOC / others have need for dedicated systems (Integrated trailer/ECU/generator)
  - Need for HMMWV-transportable power in 7-20 kW range is highly evident
    - Half for electronics & other half goes to ECUs
- **Large Generator (60, 100 KW) – *not going away***
  - New systems coming out with big power needs
    - Batch Laundry, Field Food Service System, Tactical Water Purification System
  - Seeing lots of leased commercial power once USMC goes to SOA
- **Mobile Electric Power Distribution – *don't forget about this***
  - More responsive, commercial based system to be fielded in 2006

Backup Slide: Generator Distribution

ADVANCED / ALTERNATIVE POWER SOURCES

- **Radio Power Adaptors**
  - Multiple SINCGARS

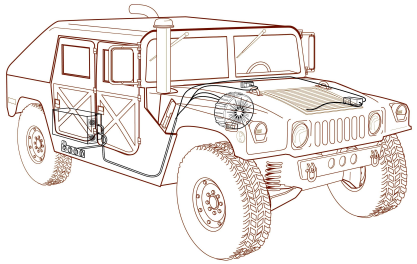
  - Single SINCGARS

  - Multi-Radio 12 V Adaptors

  - 24 V Radio Power Adapt

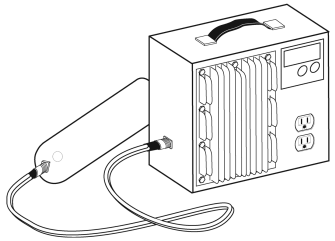
- **Power Converters**

- **On-Board Vehicle Power**



- **Solar Power Sources**

  - Power Supply
  - Battery Charger
  - Radio Power Adaptor
  - Computer Power Adaptor
- **Fuel Cells**



ALTERNATIVE POWER SOURCES FOR COMMUNICATIONS EQUIPMENT (APSCE)

Suite of devices used to:

- **Power C4I equipment**
- **Realize cost avoidance**
- **Reduce logistics burden**
- **Reduce battery use**
- **Exploit Commercial Off-the-Shelf items**

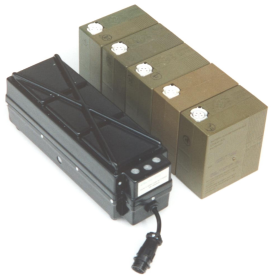
Testing:

- **Mil-Std-810 and Mil-PRF-28800 evaluation for all acquisitions**

BATTERY MANAGEMENT & SUSTAINMENT

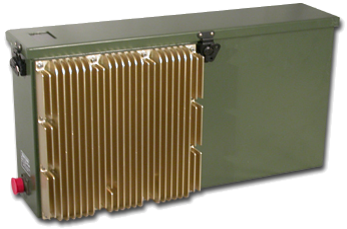
Batteries

Primary



Rechargeables

Battery Chargers



Starting, Lighting & Ignition Batteries

Policies, Studies & Evaluation

- MCCDC Overarching Battery Study
- Lithium Battery Safety Program
- Marine Corps Order - - - Battery Conservation

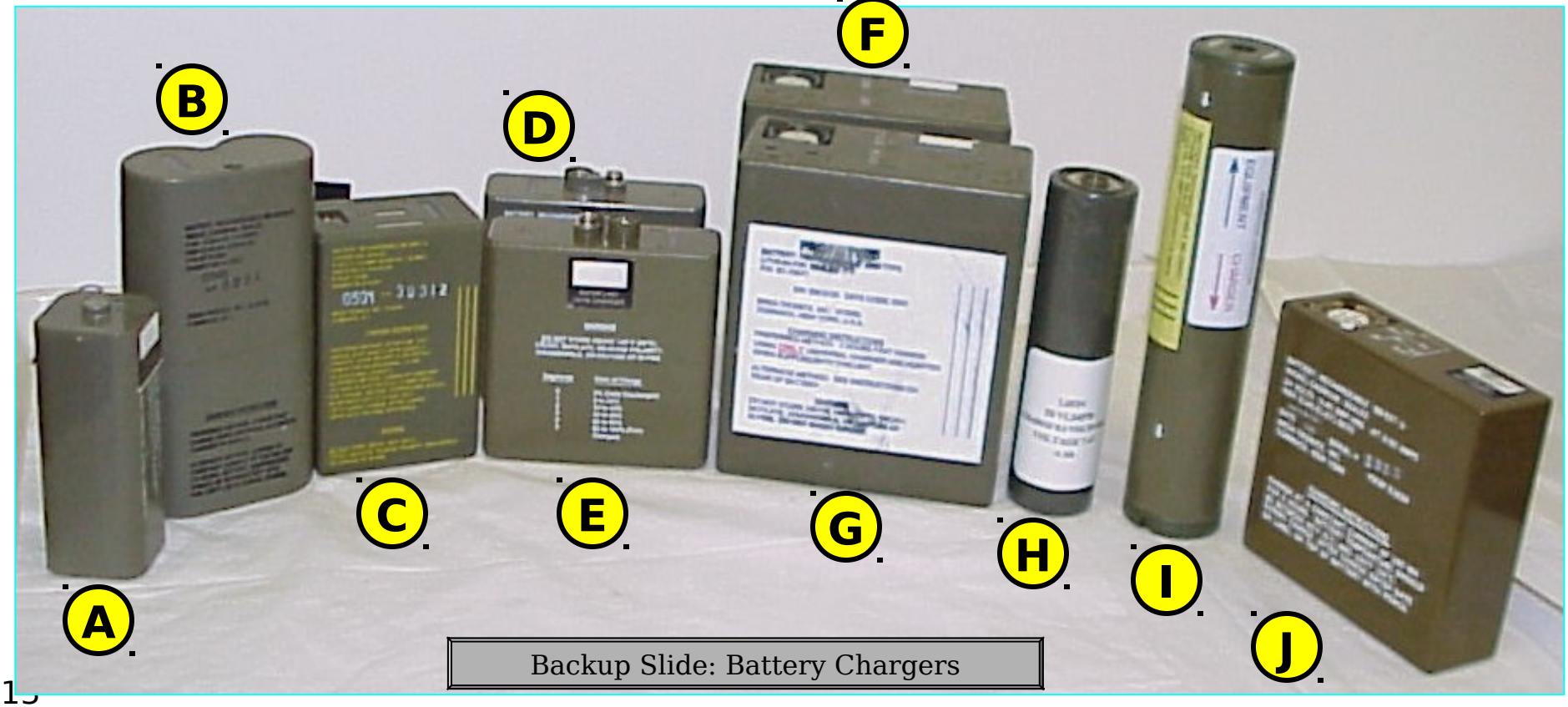
OVERARCHING BATTERY STUDY

- Last study of USMC battery users:
  - Conducted in 1996
  - 277 Principal End Items use batteries
- This study:
  - Conducted in 2003/04 (MCCDC S&A, MCSC PM-EPS)
  - Over 600 Principal End Items use 65 different battery types
    - DOD centrally manages 11 battery configurations
  - Update, and Expansion of Master Battery List
  - Characterization of battery consuming PEIs
  - Creation / distribution / training of a battery planning tool
  - Already paying off with battery planning with JCS/PACOM/LOGCOM

Backup Slide: User Model

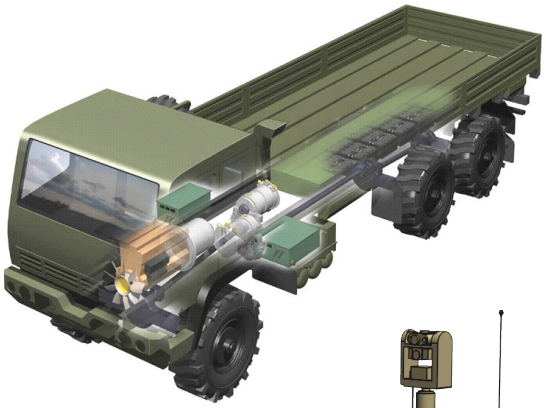
Military Rechargeable Batteries

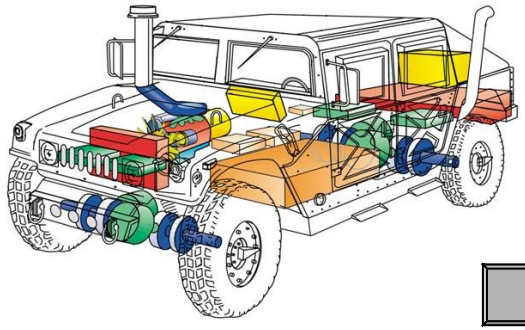
A. BB- 516A NiCad
B. BB- 503A NiCad
C. BB- 2847A Li Ion
D. BB- 2588 Li Ion
E. BB- 388A NiMH
F. BB- 390B NiMH
G. BB- 2590 Li Ion
H. BB- 2800 Li Ion
I. BB- 2600A Li Ion
J. BB- 2557 Li Ion



Backup Slide: Battery Chargers

Hybrid Electric Vehicle Status

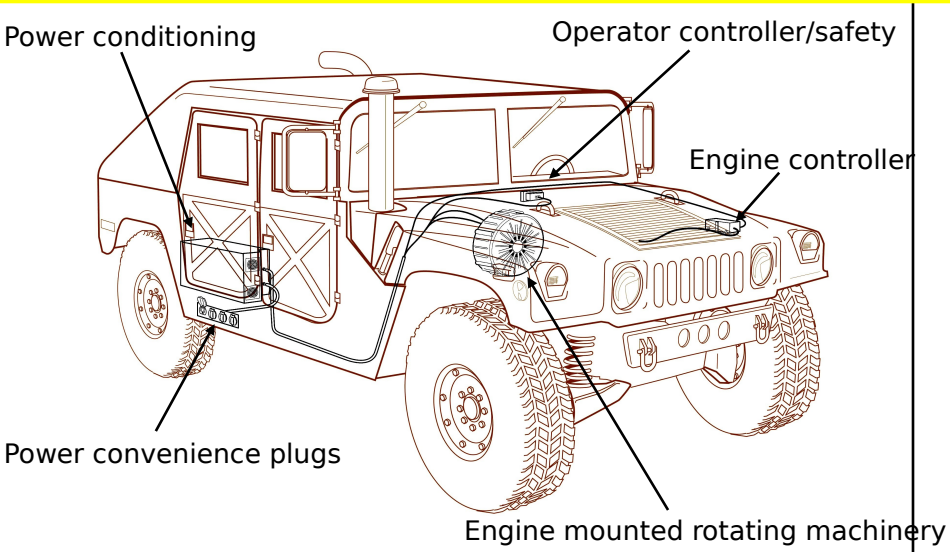




- Stand-Alone PME brief available
  - Updated annually to reflect programs & technology
  - Can be tailored / provided for any type audience
- Topics addressed
  - What is a Hybrid Electric Vehicle (HEV)
  - Who is doing what with HEVs
    - Commercial Industry
    - Military Industry
    - Other Services / Agencies
    - Other US Government Departments
  - Where are the Technical Challenges / Payoffs
  - What are USMC issues / intent for this technology

Backup Slide: HEV Conclusions

On-Board Vehicle Power - Small



Power Generation System	Cost $ per kilowatt	Weight Lbs. per kilowatt	Embarkation Sq ft required
3 kw Tactical Quiet Generator	$3200	108 lbs	7 ft2
10 kw Tactical Quiet Generator	$1455	101 lbs	14 ft2
8 kw On-Board Vehicle Power System	$1100 - $1800	18-30 lbs	0

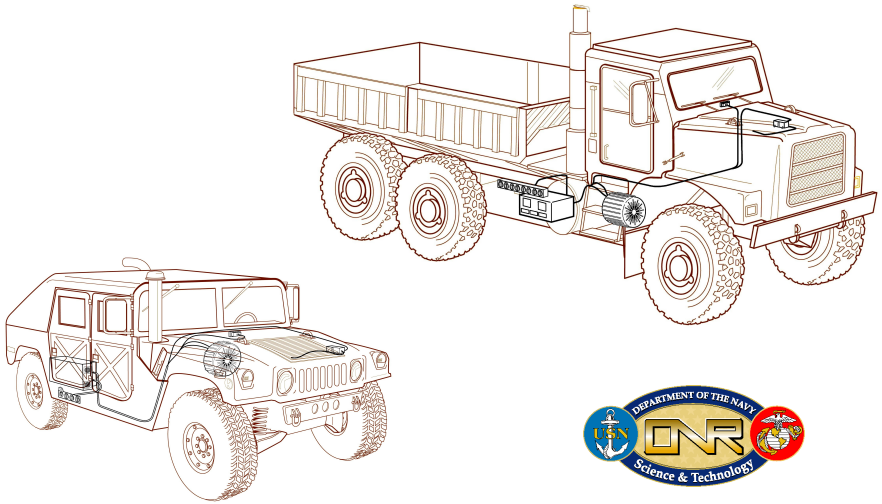
Approach:

- Integrate under-the-hood power on HMMWV (A2)
- No degradation to platform reliability and durability.
- Provide reliable **5 - 8kW 60Hz AC** electrical power
- Power during stationary & on-the-move modes
- Possible solutions:
  - Remove-&-replace component for existing alternator
  - New item driven off of engine fan belt
- Program is funded by Commercial Technology Transition Office

Program Activities:

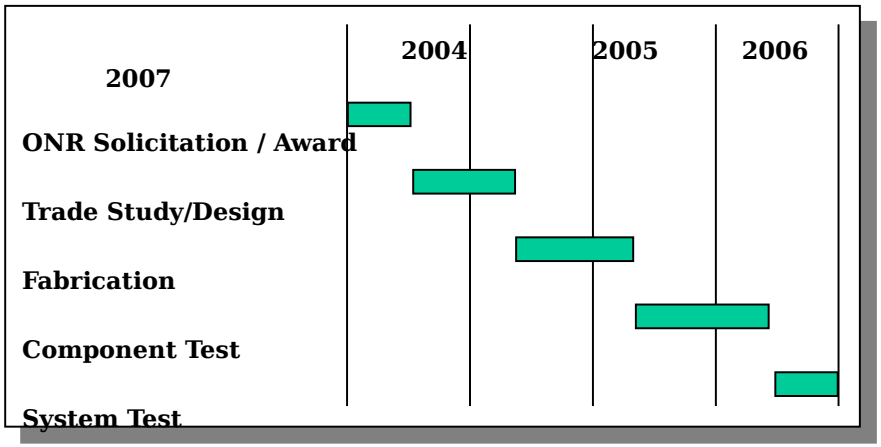
- RFI promulgated in 2003 - Seven (7) responders
- Business Case Analysis underway - FY 04
- Power Qualification & Technical Testing - FY 04
- Select USMC configuration - FY05
  - Limited User's Evaluation - FY 05
  - Durability Testing - FY 05
- Provide data to PMs / FMF
- To be fielded as SAC I item. as-required

On-Board Vehicle Power - Large



TECHNICAL:

- Provide under-the-hood or off-the-gearbox power for mounted applications that high high electrical power needs
- Three (3) Power Configurations - **20 kW, 30 kW, 60 kW**
- Two (2) vehicle configurations – HMMWV & MTVR
- Support missions with dedicated vehicles that currently use APUs, non-standard generators, or towed generators: Mobile C2, Radar, Air Defense Sensors, NBC, Ops Centers
- Program is funded by ONR for Advanced Capability Electrical Systems (ACES) Future Naval Capability

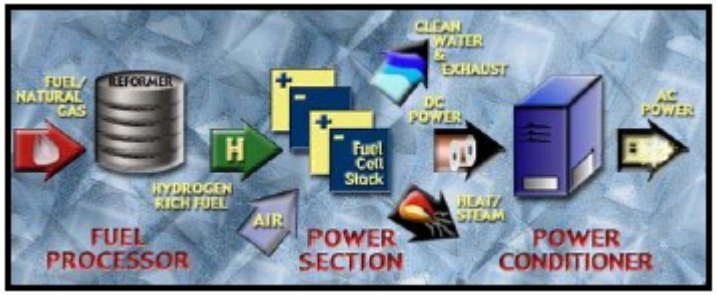


Program Timeline is funding driven

CONFIGURATIONS

- <u>OBVP Configuration 1</u>
  - 20 kilowatts continuous – HMMWV M1123
  - 120 VAC, 60 hz electric power with MEP-805B syncing
- <u>OBVP configuration 2</u>
  - 60 kilowatts continuous – MTVR Mk 23
  - 120 VAC, 60 hz electric power with MEP-806B TQG syncing
- <u>OBVP configuration 3</u>
  - Deliver 30 kilowatts continuous – HMMWV M1123
  - 120 VAC, 60 hz electric power
  - Two vehicles capable of being connected in parallel
  - Provide syncing signals to MEP-806B TQG

Fuel Cell Power Sources



- Numerous Systems Demonstrated, but …
  - Components still need to be ruggedized
  - Fuel supply is key issue to address
- For **Individual** Systems (20 – 100 W)
  - Army focus is on packaged fuels
  - Direct and reformed methanol; stored hydrogen
- For **APU** Systems (500W – 10 kW)
  - Need reformation of high energy hydrocarbon fuels
  - “Clean” diesels – leverage off commercial sector
  - Need de-sulfurization for military fuels
  - Must address the SINGLE FUEL policy
- For **Propulsion** Systems (50 kW - 300 kW)
  - Leverage off commercial industry
  - Long-term Industry vision is HEV + fuel cell
  - Use reformed gasoline / diesel or high pressure H2
- USMC experimentation underway
  - PM Expeditionary Power Systems
  - PM Intel
  - PM Marine Expeditionary Rifle Squad

Fuel remains #1 Issue

Some thoughts for the Group

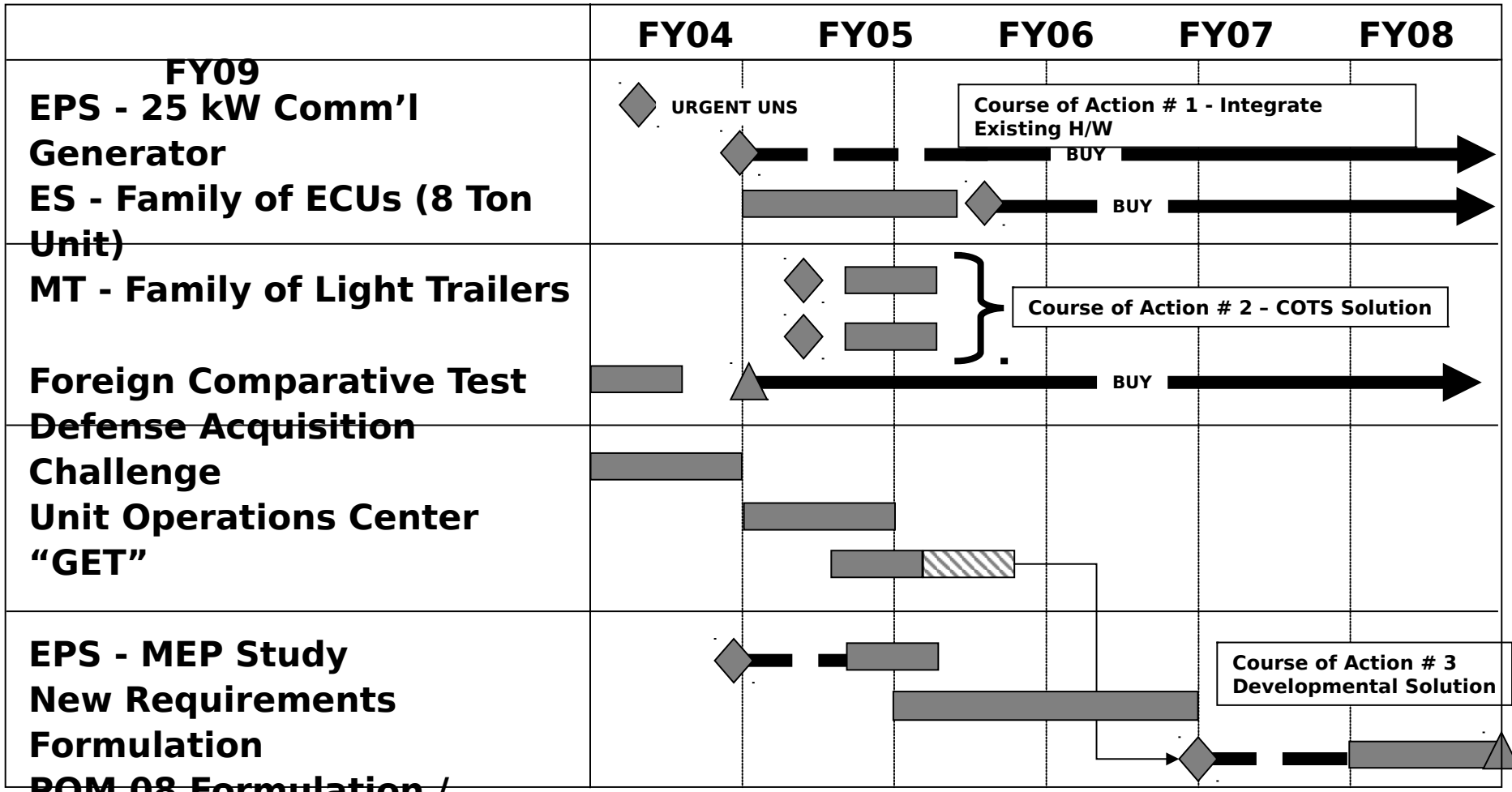
- How "***mobile***" does Mobile Electric Power need to be?
  - Backup Slide: Integrated Generator / ECU / Trailer
- Programs are fielding non-standard equipment in order to meet strenuous requirements
- Battery shortages are not a thing of the past:
  - Industrial base is still limited
  - Planning is still key
  - Advanced & Alternative Power Sources are making headway – but funding limited
- Freight train is heading towards us:
  - I MEF / II MEF equipment turn-over
  - MPF shortages to meet OIF needs

BACKUP

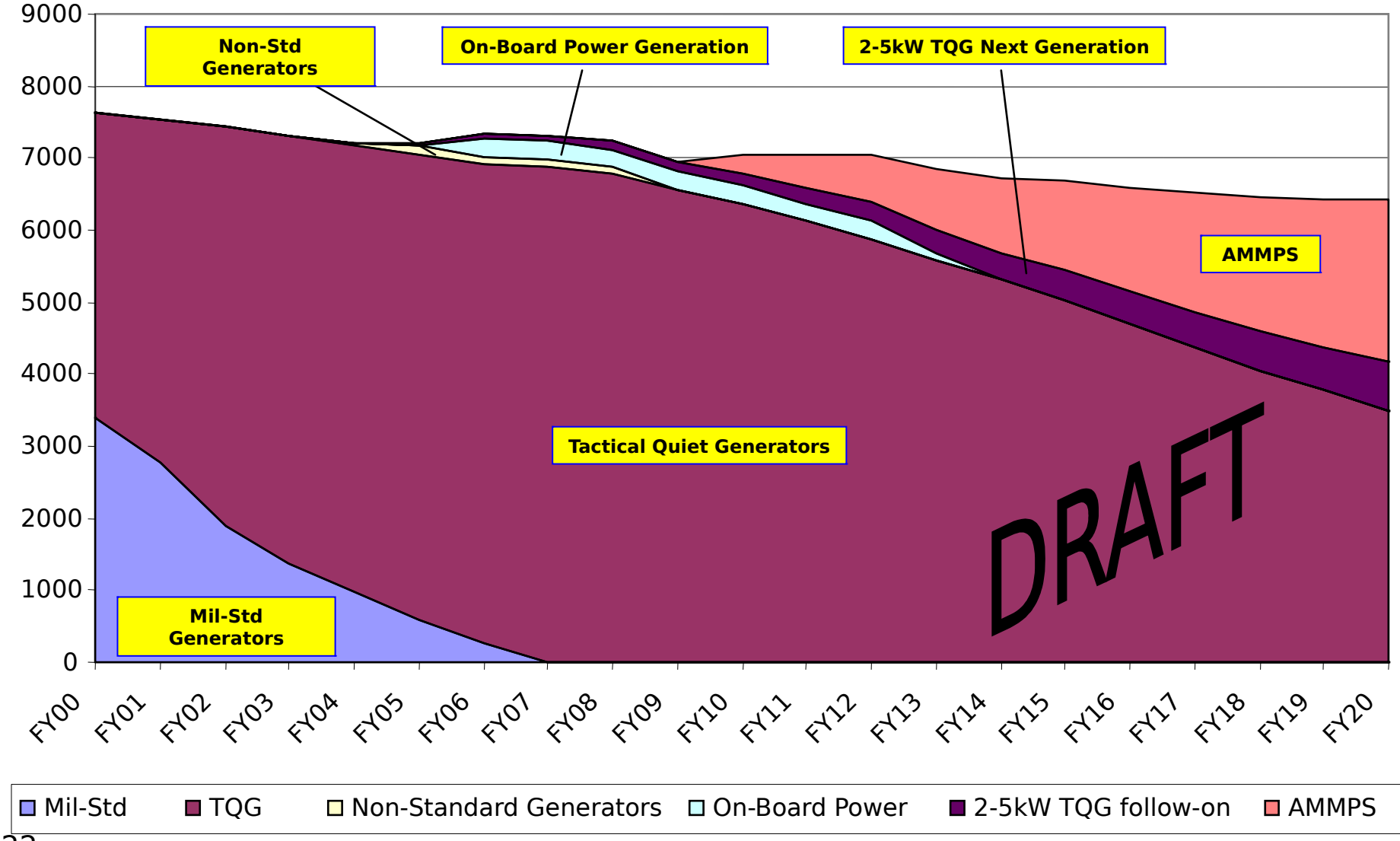
Integrated Trailer-Generator-ECU

- **Background**
  - UOC Program is developing & fielding a non-standard system with:
    - 22 kW generator
    - 96K BTU ECU
    - HMMWV towable system
  - System will be dedicated capability to only the UOC system
  - Has no backup / paralleling capability
  - MEFs are buying similar systems from commercial vendors
  - NONE of these systems have passed environmental and mobility testing
  - MEP Study is identifying need for ~ 400 systems (800 with backup power)
- **Recommended Plan of Action**
  - Draft SON / UNS to address this as a non-dedicated capability
  - Staff for FMF / Reserves validation & AAO determination
  - Initiate Requirements process to allow POM 08 competition
  - Initiate research to investigate potential alternatives

Integrated Trailer-Generator-ECU



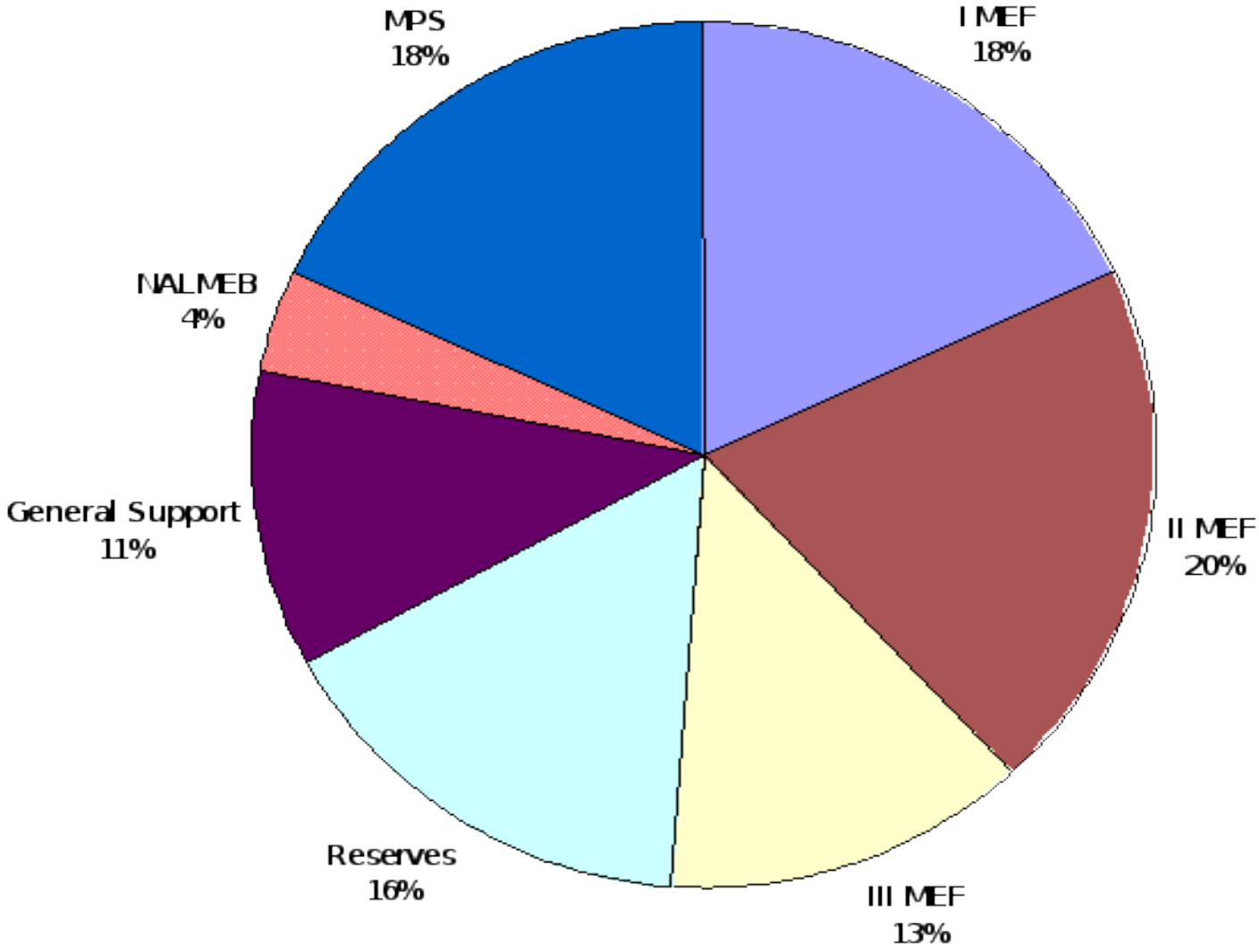
Notional Future Power Mix



Advanced Medium Sized Mobile Power Sources (AMMPS)

- Third generation of military tactical generators
- PM-MEP is lead / USMC will be portion of the buy
- Will replace ALPHA & BRAVO series TQGs
  - Addresses 5kW to 60 kW
  - 3 kW TQG will stay in production until 2010
- USMC planned fielding for AMMPS to start in 2010
- Technology assessments looked at:
  - Will be electronically controlled, reciprocating engine
  - Diesel / JP-8 power plant
- Improvements over current TQGs:
  - 15 – 50 % Smaller
  - 15 – 50 % Lighter (fleet and individually)
  - 15 – 50 % More Fuel Efficient
  - 5 – 10 dBA Quieter
  - 20 – 50 % More Reliable
  - EPA Compliant
- Skid & Trailer mounted
- Army will field with a 2-Level Maintenance / USMC must adapt TMs to 3-Level

MEP Distribution



Sample from Master Battery List

TAMCN	Nomenclature, JTIDS	End Item Quantities	Principal Battery Type (New Name)	Principal Battery Type (Old Name)	Principal Battery Quantity	Principal Battery NSN	Alternate Battery NSN 1	Additional / Alternate NSN 2
Note:	The item quantities for Type 2 TAMCNs (i.e., F, H, J, K and N) are determined by the local commanders. * - Denotes equipment that is powered by external batteries. ** - System is still being developed or has recently been fielded. Battery details and NSNs are evolving.							
A0009	CONVERTER, MODEM, CV3591(P)/U (KYV-5)	359	BA-5372/U		1	6135-01-214-6441		
A0011	FIRE SUPPORT COMMAND AND CONTROL SYSTEM, AN/UYK-102	530	EN22, MN1604	BA-3090/U	1	6135-00-900-2139	6135-01-369-9792	
A0086 *	SHOP EQUIPMENT, CONTACT MAINT, AVENGER, AN/MSM-126 (Vehicle)	7	6TMF (Dry)		2	6140-01-446-9498	6140-01-485-1472	6140-01-210-1064
	SHOP EQUIPMENT, CONTACT MAINT, AVENGER, AN/MSM-126 (Flashlight)		E95, MN1300	BA-3030/U	2	6135-00-835-7210	6140-01-350-9558	
A0087	SHOP SET, EQUIPMENT, MAINT, AVENGER, AN/TSM-206 (Flashlight)	4	E95, MN1300	BA-3030/U	4	6135-00-835-7210	6140-01-350-9558	
A0248	CENTRAL OFFICE, TELEPHONE, AUTOMATIC, AN/TTC-42(V) (Electric Lantern)	55	509, M908, EV90	BA-200/U	1	6135-00-643-1310		

Battery Requirements

		Principal Battery					Alternate Battery 1					Alternate Battery 2				
TAMCN	Nomenclature, JTIDS	Battery Life in Hours (Hb,e,2)	Average Current Drawn in Amps (Ib,e)	Battery Capacity in Amp Hours (Fb,2)	Parametric	Source	Battery Life in Hours (Hb,e,2)	Average Current Drawn in Amps (Ib,e)	Battery Capacity in Amp Hours (Fb,2)	Parametric	Source	Battery Life in Hours (Hb,e,2)	Average Current Drawn in Amps (Ib,e)	Battery Capacity in Amp Hours (Fb,2)	Parametric	Source
Note:	The item quantities for Type 2 TAMCNs (i.e., F, H, J, K and N) are determined by the local commanders.															
	* - Denotes equipment that is powered by external batteries.															
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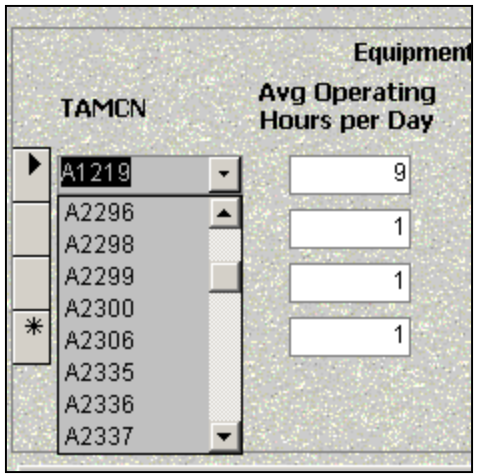
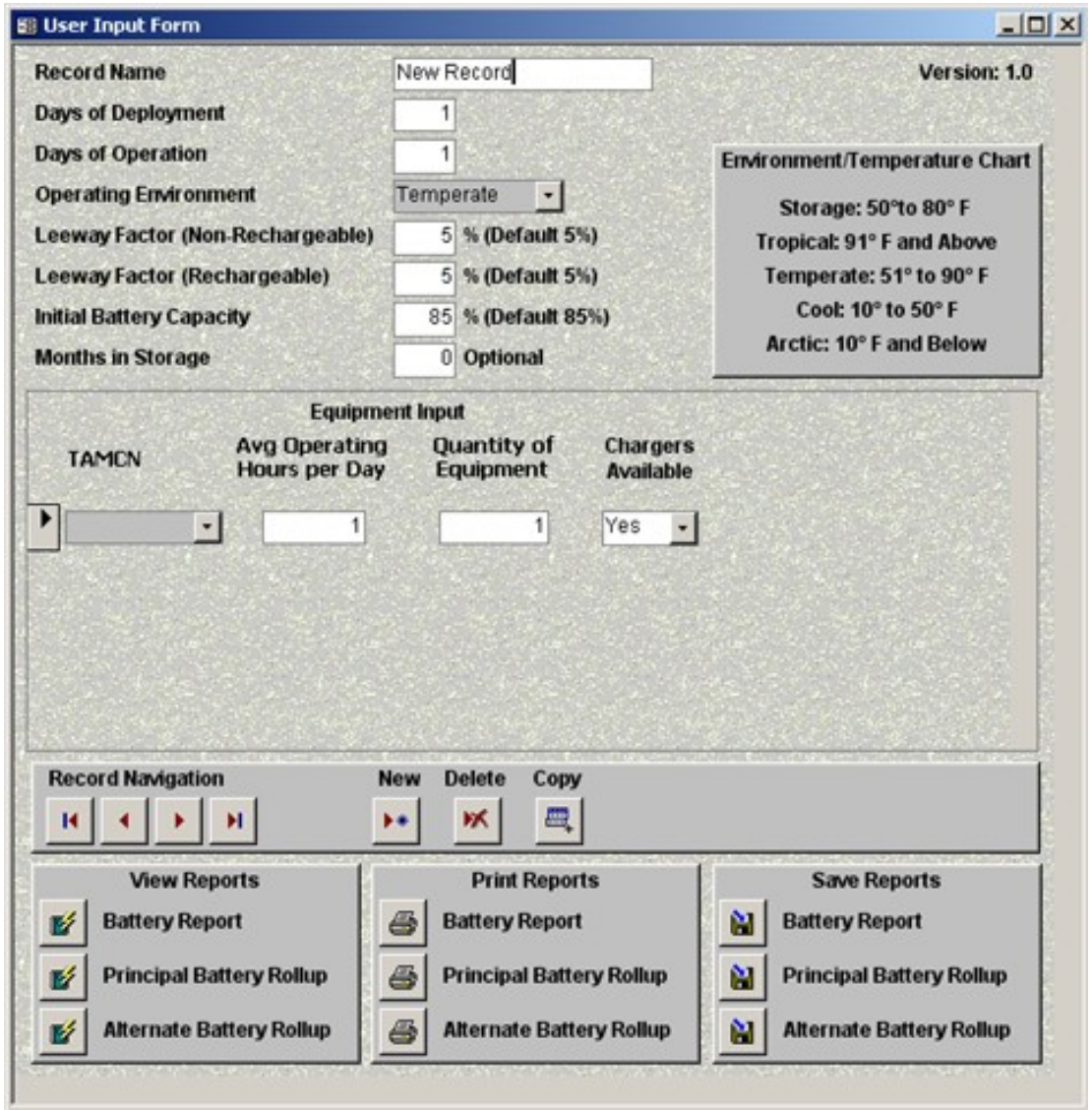
	MOBILE EW SUPPORT SYSTEM (MEWSS) PIP, AN/MLQ-36A (Telephone Set, TA-838A)		0.001	6.47		TM 11-5805-650-12		0.001	6.47		Match Principal Battery					
	MOBILE EW SUPPORT SYSTEM (MEWSS) PIP, AN/MLQ-36A (AN/GRC-231A(V)2)	25.00			D1001											
	MOBILE EW SUPPORT SYSTEM (MEWSS) PIP, AN/MLQ-36A (AN/PRC-68)	33.00				SB 11-6	23.1				Match Principal Battery	23.1				Match Principal Battery
	MOBILE EW SUPPORT SYSTEM (MEWSS) PIP, AN/MLQ-36A (AN/VRC-92A)	4,380.00				SB 11-6										
A1219	EQUIPMENT PROGRAM, RECON, RADIO, SS2 (Radio)	30.00			A2070		21.0				CECOM Web Site - Rechargeables	45.0				Ultralife Product Summary Guide
	EQUIPMENT PROGRAM, RECON, RADIO, SS2 (Panasonic CF-73 Toughbook Laptop)	4.50				Panasonic Web Site										
A1221	MONITOR, PORTABLE, AN/USQ-121	24.00				TM-2000-15/2B	16.8				Match Principal Battery					
A1225	NETWORK MANAGER, EPLRS (Ruggedized Laptop)	4.50				Panasonic Web Site										
A1226	STATION, NET CONTROL, ENHANCED, DOWNSIZED, AN/TSQ-158(V)4 (CYZ-10)	720.00				TM 11-5810-394-20/P	720.00				Match Principal Battery	720.0				Match Principal Battery

Battery Model User Input Form

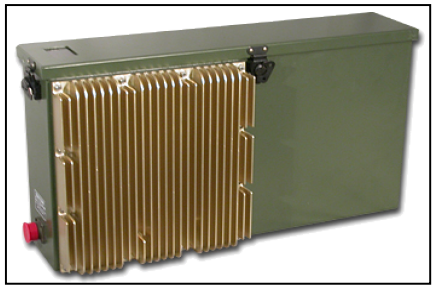




HEV Conclusions

- **Hybrid Electric Vehicles are still complex initiatives**
  - **Takes time (components, software, integration)**
  - **Takes money (dedicated R&D, multi-year)**
- **Tremendous efforts have been put forth in the past (>$200M)**
- **Army continues future efforts**
- **Many initiatives have concluded without fielding due to lack of requirements and business case**
- **Repeated studies (Commercial and Military) have shown fuel efficiency is not a key driver**
- **Most benefits offered by Hybrid Electric Vehicles are trade-able requirements**
- **USMC has no new “official” HEV programs or development efforts**
- **On-board vehicle power being developed (multiple sizes) to fill need, at lower risk**
- **PM EPS is doing a Business Case Analysis for On-Board Power**

Comm-Elec Battery Chargers



- Garrison Battery Chargers fall under PM TMDE
- Tactical Battery Chargers fall under PM EPS
- USMC PP-8444 - “Universal Portable Battery Charger”
  - Only current USMC fielded CE battery charging system
  - Can use AC or vehicle DC power
  - Plugs in and charges 2 batteries at a time
  - Can not handle new battery chemistries
- Army System PP-8481/U – Vehicle "Charger on the Move"
  - Mounts in vehicle or bench-top
  - AC or DC power, handles new chemistries
  - 2 Battery adaptor positions, 5-6 batteries at a time
  - SAC I item – unit funded / as-required
- Army System PP-8498/U - "Soldier Portable Charger"
  - AC or DC power, handles new chemistries
  - Can plug in up to 8 batteries, charges only 2 at a time
  - SAC III item – MCSC funded
- Battery study addresses charger availability for planning

RST-V Demonstration Status

- **Key Performance Parameters for Demonstration:**
  - **System Reliability**
  - **System Supportability**
  - **Power generation of 20kW (T), 30 kW (O)**
  - **Demonstration of Hybrid Electric Technology**
- **Demonstration in two separate & distinct phases.**
  - **Tec CONUS eva**
  - **OI entation (2 RS**